# CHAOS AND QUANTUMLIKE MECHANICS IN ATMOSPHERIC FLOWS : A SUPERSTRING THEORY FOR SUPERGRAVITY

A.MARY SELVAM

*Indian Institute of Tropical Meteorology,*
*Dr.Homi Bhabha Marg,Pashan,Pune 411 008,India*

The author has identified quantumlike mechanics in atmospheric flows with intrinsic nonlocal space-time connections manifested as the selfsimilar fractal geometry to the global cloud cover pattern concomitant with inverse power law form for power spectra of temporal fluctuations. Such long-range spatiotemporal correlations are generic to dynamical systems in nature and are recently identified as signatures of selforganized criticality, a field of study belonging to the newly emerging discipline of nonlinear dynamics and chaos. The author has presented a universal thory of chaos which postulates that spatial integration of enclosed small scale fluctuations result in the generation of a hierarchical scale invariant eddy continuum(network) with ordered two-way energy flow between the scales. The model concepts lead to the following results. (1) The eddy energy spectrum follows normal distribution characteristics,i.e.,the square of the eddy amplitude represents the probability density,a result which is observed in the subatomic dynamics of quantum systems. (2) Wave-particle duality is attributed to the bimodal (formation and dissipation) phenomenological form for manifestation of energy in the bidirectional energy flow intrinsic to eddy circulations,e.g., formation and dissipation respectively of clouds in updrafts and downdrafts of atmospheric eddies. (3) The nested continuum of eddy flow trajectories follow Kepler's third law of planetary motion. Therefore,inverse square law form for centripetal force, representing inertial or gravitational force is intrinsic to the hierarchical eddy continuum. The above model is analogous to a superstring model where manifestation of matter is visualised as vibrational modes in stringlike energy flow patterns.

## 1 Introduction

Atmospheric flows exhibit selfsimilar fluctuations on all scales (space-time) ranging from climate (kilometers/years) to turbulence (millimeters/seconds) manifested as the fractal geometry to the global cloud cover pattern concomitant with inverse power law form for power spectra of temporal fluctuations. Selfsimilar fluctuations implying long-range correlations are ubiquitous to dynamical systems in nature and are identified as signatures of self-organized criticality [1] . Standard models in meteorological theory cannot explain satisfactorily the observed self-organized criticality in atmospheric flows. Also, mathematical models for simulation and prediction of atmospheric flows are nonlinear and computer realizations give unrealistic solutions because of deterministic chaos, a direct consequence of finite precision round-off error doubling for each iteration of iterative computations incorporated in long-term numerical integration schemes used for model solutions. An alternative non-deterministic cell dynamical system model [2] [3] [4] predicts the observed self-organized criticality as a direct consequence of quantumlike mechanics governing flow dynamics.The model concepts show that the centripetal acceleration representing the inertial mass of eddy circulation follows inverse square law form analogous to Newton's third law for planetary motion.

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## 2  Model Concepts

Atmospheric flows is a representative example of turbulent fluid flows. The model is based on the concept that spatial integration of enclosed small scale(turbulent eddy) fluctuations result in organized large eddy circulations.The eddy energy spectrum therefore follows statistical normal distribution characteristics according to the Central Limit Theorem. Therefore,the square of the eddy amplitude,i.e., variance represents the statistical normal probability density distribution.Such a result that the additive amplitudes of eddies,when squared, represent probability densities is observed in the sub-atomic dynamics of quantum systems such as the electron or photon. Atmospheric flows therefore follow quantumlike mechanical laws. The root mean square(r.m.s) circulation speed W of large eddy of radius R is then given in terms of enclosed small scale eddy circulation speed w and radius r as

$$W^2 = \frac{2}{\pi} \frac{r}{R} w^2 \qquad (1)$$

The square of the eddy amplitude $W^2$ represents the kinetic energy E given as(from Eq.1)

$$E = H\nu \qquad (2)$$

where $\nu_R$(proportional to 1/R ) is the frequency of the large eddy and H is a constant equal to $\frac{2}{\pi}rw^2$ for growth of large eddies sustained by constant energy input proportional to $w^2$ from fixed primary small scale eddy fluctuations. Energy content of eddies is therefore similar to quantum systems which can possess only discrete quanta or packets of energy content $h\nu$ where h is a universal constant of nature (Planck's constant) and $\nu$ is the frequency in cycles per second of the electromagnetic radiation. The relative phase angle between large and turbulent eddies is equal to r/R and is directly proportional to $W^2$(Eq.1). The phase angle therefore represents variance and also there is progressive increase in phase with increase in wavelength. The above relationship between phase angle, variance and frequency has been identified as Berry's Phase [5] in the subatomic dynamics of quantum systems.Writing Eq(1) in terms of the periodicities $T(= 2\pi R/W)$and $t(= 2\pi r/w)$ of large and small eddies respectively we obtain

$$\frac{R^3}{T^2} = \frac{2}{\pi}\frac{r^3}{t^2} \qquad (3)$$

Eq.(3) is analogous to Kepler's third law of planetary motion, namely,the square of the planet's year(period) to the cube of the mean distance from the Sun is the same for all planets and results in inverse square law analogous to the Newton's inverse square law for gravitation [6] . The model is similar to a superstring model for subatomic dynamics [7] which unifies quantum mechanical and classical concepts and incorporates gravitational forces along with nuclear and electromagnetic forces.The cumulative sum of centripetal forces in a hierarchy of vortex circulations may result in the observed inverse square law form for gravitational attraction between inertial masses (of the eddies). The apparent paradox of wave-particle duality in microscopic scale quantum systems is however physically consistent in the context

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of macroscale atmospheric flows since the bi-directional energy flow structure of a complete atmospheric eddy results in the formation of clouds in updrafts region and dissipation of clouds in downdraft regions.The commonplace occurrence of clouds in a row is a manifestation of wave-particle duality in the macroscale quantum system of atmospheric flows. The above-described analogy of quantum-like mechanics for atmospheric flows is similar to the concept of a subquantum level of fluctuations whose space-time organization gives rise to the observed manifestation of subatomic phenomena,i.e.,quantum systems as order out of chaos phenomena [8]. H.E.Puthoff [9] has also put forth the concept of "Gravity as a zero-point fluctuation force". The vacuum zero-point fluctuation(electromagnetic) energy manifested in the Casimir effect is analogous to the turbulent scale fluctuations whose spatial integration results in coherent large eddy structures.

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